This listing of claims will replace all prior versions, and listings, of claims in the application:

IN THE CLAIMS:

1. (Canceled) A volume hologram comprising a plurality of diffractive elements exhibiting a positional variation in at least one of amplitude, optical separation, and spatial phase over some portion of the thickness of the volume, the diffractive elements interacting with an input optical signal having a first spatial wavefront and a first optical spectrum to produce an output optical signal having a second spatial wavefront and a second optical spectrum, wherein the first spatial wavefront differs from the second spatial wavefront, and wherein the first optical spectrum differs from the second optical spectrum.

2. (Canceled) The volume hologram of claim 1 wherein the first spatial wavefront originates from an input optical waveguide.

3. (Canceled) The volume hologram of claim 1 wherein the second spatial wavefront converges to an output optical waveguide.

4. (Canceled) The volume hologram of claim I further comprising a bulk substrate.

5. (Canceled) The volume hologram of claim 1 where the hologram resides within a planar waveguide.

6. (Canceled) The volume hologram of claim 1, where each of the diffractive elements has a spherical contour and a center of curvature.

7. (Canceled) The volume hologram of claim 6, wherein the centers of curvature of a plurality of the diffractive elements are coincident.

8. (Canceled) The volume hologram of claim 7, wherein the input optical signal originates from an input waveguide and the output optical signal converges to an output waveguide, the respective input and output waveguides located at respective conjugate image points of the plurality of the diffractive elements whose centers of curvature are coincident.

9. (Canceled) The volume hologram of claim 1 wherein the propagation direction of the input optical signal is not collinear to the propagation direction of the output optical signal.

10. (Canceled) The volume hologram of claim 1 wherein the input optical signal is an optical pulse.

11. (Canceled) The volume hologram of claim 1, further comprising a programmed spectral transfer function comprising a conjugate Fourier transform $Ei^*(\omega)$ of a design temporal waveform $Ei(t)$.

12. (Currently Amended) An optical apparatus, comprising:

a substrate that propagates optical signals in at least two dimensions, the substrate having a first port and a second port;

~~a first port;~~

~~a second port; and~~

a plurality of diffractive elements within the substrate, the plurality of diffractive elements being arranged such that

the plurality of diffractive elements exhibit a positional variation in at least one of amplitude, optical separation, and spatial phase over some portion of the substrate,

each of the plurality of diffractive elements individually provides reciprocal

focusing between the first port and the second port, and

when a first optical signal having a first spatial wavefront and a first temporal waveform is introduced into the substrate through the first port, the plurality of diffractive elements

apply a transfer function to the first optical signal to produce a second optical signal having a second spatial wavefront and a second temporal waveform, wherein the first and second spatial wavefronts differ in at least spatial wavefront shape and the first temporal waveform differs from the second temporal waveform, and

focus the second optical signal to exit the substrate through the second port.

13. (Previously Presented) The apparatus of claim 12 wherein the input optical signal includes an optical pulse.

14. (Previously Presented) The apparatus of claim 12, further comprising an input optical waveguide for introducing an input optical signal into the substrate through the first port.

15. (Previously Presented) The apparatus of claim 12, further comprising an output optical waveguide for receiving an output optical signal exiting the second port.

16. (Currently Amended) The apparatus of claim 12, wherein the optical device forms ~~an~~a temporal ~~optical~~ waveform cross-correlator.

17. (Canceled)

18. (Previously Presented) The apparatus of claim 12, where each of the diffractive elements has a spherical contour and a center of curvature.

19. (Previously Presented) The apparatus of claim 18, wherein the centers of curvature of the diffractive elements are coincident.

20. (Previously Presented) The apparatus of claim 19, further comprising:

an input waveguide, and

an output waveguide,

wherein the input optical signal originates from the input waveguide and the output optical signal converges to an output waveguide, with the respective input and output waveguides located at respective conjugate image points of the plurality of the diffractive elements whose centers of curvature are coincident.

21. (Previously Presented) The apparatus of claim 12 wherein the first port is separated from the second port by a distance equal to or less than about 5000 microns.

22. (Previously Presented) The apparatus of claim 12 wherein the first port is separated from the second port by a distance between about 5000 microns and about 25 microns.

23. (Previously Presented) The apparatus of claim 12 wherein a propagation direction of the input optical signal is not collinear to a propagation direction of the output optical signal.

24. (Canceled) The apparatus of claim 12 wherein all diffractive elements have an elliptical contour, with each diffractive element having a first focus and a second focus, and wherein a plurality of the respective first foci of the diffractive elements coincide, and a plurality of the respective second foci of the diffractive elements coincide.

25. (Canceled) The apparatus of claim 24, wherein the input optical signal originates from an input waveguide and the output optical signal converges to an output waveguide, and where

the respective input and output waveguides are located at the respective foci of the diffractive elements whose respective first foci coincide, and whose respective second foci coincide.

26. (Canceled) An apparatus comprising

an input port operative to launch an input optical signal having an input spatial wavefront and an input optical spectrum;

a volume hologram comprising a plurality of diffractive elements exhibiting a positional variation in at least one of amplitude, optical separation, and spatial phase over some portion of the thickness of the volume, the volume hologram interacting with an input optical signal having an input spatial wavefront and an input optical spectrum, to produce a plurality of output optical signals each with a respective output spatial wavefront and a respective output optical spectrum, at least one output optical signal whose output optical spectrum is distinguishable from the other output optical spectra and which has a direction of propagation that differs from the respective directions of propagation of all of the other output optical signals; and

a plurality of output ports, configured to accept and transmit the plurality of output optical signals.

27. (Canceled) The apparatus of claim 26 wherein the input optical signal comprises a plurality of wavelength differentiated communication channels, and wherein at least one output optical signal comprises fewer than all of the plurality of wavelength differentiated communication channels that comprise the input optical signal, the at least one output optical signal having a direction of propagation differing from the respective directions of propagation of the other output optical signals.

28. (Canceled) The apparatus of claim 26, wherein each output optical signal comprises a single wavelength differentiated communications channel, and wherein each output optical signal is focused to a location that differs from the respective locations of focus of each of the other respective output optical signals.

29. (Canceled) The apparatus of claim 27, wherein at least one output optical signal comprises more than one wavelength differentiated communications channel.

30. (Canceled) An apparatus comprising

a plurality of input ports, each operative to launch at least one of a plurality of input optical signals, each input optical signal having a spatial wavefront and an optical spectrum;

a volume hologram comprising a plurality of diffractive elements exhibiting a positional variation in at least one of amplitude, optical separation, and spatial phase over some portion of the thickness of the volume, the volume hologram interacting with the plurality of input optical signals having respective input spatial wavefronts and respective input optical spectra, to produce an output optical signal having an output spatial wavefront and an output optical spectrum; and

an output port configured to accept and transmit the output optical signal.

31. (Canceled) The apparatus of claim 30 wherein the plurality of input optical signals comprises a plurality of wavelength differentiated communications channels.

32. (Canceled) The apparatus of claim 30 wherein each optical input signal comprises a single wavelength differentiated communications channel.

33. (Canceled) The apparatus of claim 30 wherein at least one input optical signal comprises a plurality of wavelength differentiated communications channels.

34. (Canceled) An apparatus comprising

an input port operative to launch an input optical signal having an input spatial wavefront and an input temporal waveform;

a volume hologram comprising a plurality of diffractive elements exhibiting a positional variation in at least one of amplitude, spatial separation, and spatial phase over some portion of the volume of the hologram,

the volume hologram interacting with the input optical signal to produce a plurality of output optical signals, each output optical signal having a respective output spatial wavefront that differs from the respective output spatial wavefront of at least one of the other output optical signals, each output optical signal having a respective output temporal waveform, wherein at least two of the output optical signals have respective output temporal waveforms that differ from one another; and

a plurality of output ports configured to accept and transmit at least two of the plurality of output optical signals,

wherein each portion of the first spatial wavefront contributes to each of the output optical signals by scattering from the diffractive elements during propagation through the volume hologram over a distance large enough so that temporal retardation effects within the volume hologram transform the first temporal waveform into the respective output temporal waveforms.

35. (Previously Presented) The apparatus of claim 137 wherein the first optical signal is an optical pulse.

36. (Canceled) A method comprising:

receiving from at least one input, an input optical signal having a first spatial wavefront and a first optical spectrum and a first direction of propagation in a volume hologram comprising a plurality of diffractive elements;

diffracting an input optical signal via the diffractive elements, producing a diffracted optical signal having an optical spectrum that differs from the input optical spectrum, the diffracted optical signal having second direction of propagation; and

transmitting the diffracted optical signal, the diffracted optical signal comprising a second spatial wavefront, wherein the first and second spatial wavefronts are not identical in shape.

37. (Canceled) The method of claim 36, wherein the volume hologram further comprises spatial transformation information.

38. (Canceled) The method of claim 36 wherein the propagation direction of the input optical signal is not collinear to the propagation direction of the diffracted optical signal.

39. (Canceled) The method of claim 36 wherein the input optical signal is an optical pulse.

40. (Canceled) The method of claim 37 wherein the processed optical signal is spatially transformed.

41. (Canceled) The method of claim 36 where the volume hologram further comprises temporal transformation information.

42. (Canceled) The method of claim 41 wherein the diffracted optical signal is temporally transformed.

43. (Canceled) The method of claim 37 where the volume hologram further comprises

temporal transformation information.

44. (Canceled) The method of claim 43 wherein the diffracted optical signal is spatially and temporally transformed.

45. (Currently Amended) A method comprising:

receiving a first optical signal at a first port of an optical device, the first optical signal having a first temporal waveform and a first spatial wavefront;

diffracting the first optical signal via diffractive elements within the optical device, such that each diffractive element individually acts to provide reciprocal focusing between the first port and an output port of the optical device, so as to

apply a transfer function to the first optical signal to produce a second optical signal having a second temporal waveform and a second spatial wavefront that differs from the first temporal waveform and the first spatial wavefront; and

focus the diffracted optical signal to exit the optical device through ~~an~~ the output port.

46. (Previously Presented) The method of claim 45, wherein the transfer function includes spatial transformation information.

47. (Previously Presented) The method of claim 46 wherein the second optical signal is spatially transformed from the first optical signal.

48. (Previously Presented) The method of claim 45 wherein the first optical signal has a first direction of propagation and the second optical signal has a second direction of propagation, and where the first direction of propagation is not collinear to the second direction of

propagation.

49. (Previously Presented) The method of claim 45 wherein the first optical signal is an optical pulse.

50. (Previously Presented) The method of claim 45 wherein the transfer function includes spectral transformation information.

51. (Previously Presented) The method of claim 50 wherein the second optical signal is spectrally transformed from the first optical signal.

52. (Previously Presented) The method of claim 50, wherein the transfer function further includes spatial transformation information.

53. (Previously Presented) The method of claim 52 wherein the second optical signal is spectrally and spatially transformed from the first optical signal.

54. (Currently Amended) The method of claim 45, wherein the diffractive elements form ~~an~~a ~~optical~~ temporal waveform cross-correlator.

55. (Canceled) The method of claim 45, where the transfer function comprises a conjugate Fourier transform Ei*(ω) of a designed temporal waveform Ei(t).

56. (Canceled) A method comprising:

calculating a temporal interference pattern produced by an interference of a chosen input signal Ei(t) with an intended output signal Eo(t), the chosen input signal and the intended output signal traveling within a common boundary in a common time frame.

57. (Canceled) The method of claim 56, further comprising calculating a plurality of temporal interference patterns produced by respective interference of a plurality of chosen input

signals Ei(t) with a respective plurality of intended output signals Ei(t), and where a total temporal interference pattern is calculated as a superposition of the plurality of temporal interference patterns.

58. (Canceled) A method comprising:

imprinting on at least one slab face of a substrate, a holographic pattern comprising temporal transformation information.

59. (Canceled) The method of claim 58 wherein the holographic pattern further comprises spatial transformation information.

60. (Canceled) The method of claim 58 wherein the imprinting is accomplished using a technique chosen from the group consisting of photolithography, electron beam lithography, stamping, etching, mechanical abrasion, ultrasonic material removal, heat deformation, laser ablation, photosensitive exposure, and combinations thereof.

61. (Canceled) The method of claim 58 wherein imprinting occurs on two faces of the substrate.

62. (Canceled) A product produced according to the method of claim 58.

63. (Canceled) A method comprising:

depositing a layer on at least one slab face of a substrate;

imprinting on the layer a hologram comprising temporal transformation information.

64. (Canceled) The method of claim 63 wherein the hologram further comprises spatial transformation information.

65. (Canceled) The method of claim 63 wherein the hologram further comprises spectral

transformation.

66. (Canceled) The method of claim 63, wherein the imprinting occurs by deformation of the layer.

67. (Canceled) The method of claim 63, wherein the layer deposited is dielectric.

68. (Canceled) The method of claim 63, wherein the layer deposited is metallic.

69. (Canceled) A product produced according to the method of claim 63.

70. (Canceled) A method comprising:

depositing a layer on at least one slab face of a substrate, the layer comprising temporal transformation information.

71. (Canceled) The method of claim 70 wherein the layer further comprises spatial transformation.

72. (Canceled) The method of claim 70 wherein the layer further comprises spectral transformation.

73. (Canceled) The method of claim 70 wherein the layer is metallic.

74. (Canceled) The method of claim 70 wherein the layer is dielectric.

75. (Canceled) A product produced according to the method of claim 70.

76. (Canceled) A method comprising: imprinting a hologram comprising temporal transformation information, on at least one surface of a support slab.

77. (Canceled) The method of claim 76 wherein the hologram further comprises spatial transformation information.

78. (Canceled) The method of claim 76 wherein the hologram further comprises spectral

transformation.

79. (Canceled) The method of claim 76, further comprising pressing the support slab securely against an optical substrate.

80. (Canceled) The method of claim 76, further comprising bonding the support slab to an optical substrate.

81. (Canceled) A product produced according to the method of claim 76.

82. (Canceled) A method comprising:

selectively exposing a photosensitive substrate whose exposure changes a physical characteristic of the substrate, to make a volume hologram comprising temporal transformation information in the substrate.

83. (Canceled) The method of claim 82 wherein the volume hologram further comprises spatial transformation information.

84. (Canceled) The method of claim 82 wherein the hologram further comprises spectral transformation.

85. (Canceled) The method of claim 82 wherein the physical characteristic that is changed is at least one of absorptivity, index of refraction, and reflectivity.

86. (Canceled) A product produced according to the method of claim 82.

87. (Canceled) An apparatus comprising:

at least one input port;

at least one output port;

a planar waveguide comprising a planar boundary and a volume; and

a feedback structure comprising a plurality of diffractive elements exhibiting a positional variation in at least one of amplitude, spatial separation and spatial phase, the feedback structure further comprising a transfer function comprising temporal transformation information imprinted in a medium comprising the planar waveguide.

88. (Canceled) The apparatus of claim 87 wherein the medium comprises a material chosen from the group consisting of fused silica, polymer, silicon, and combinations thereof.

89. (Canceled) The apparatus of claim 87 wherein the at least one input port is a prism coupling.

90. (Canceled) The apparatus of claim 87 wherein the at least one output port is a prism coupling.

91. (Canceled) The apparatus of claim 87 where the transfer function further comprises spatial transformation information.

92. (Canceled) The apparatus of claim 87, where the transfer function comprises a conjugate Fourier transform Ei* (ω) of a design temporal waveform Ei(t).

93. (Canceled) The apparatus of claim 87, wherein the volume hologram is thermally stabilized.

94. (Canceled) The apparatus of claim 93 wherein thermal stabilization is accomplished by a feedback signal.

95. (Canceled) The apparatus of claim 94 where the feedback signal is provided by a reference grating.

96. (Canceled) The apparatus of claim 87 further comprising the medium having a

refractive index, wherein the diffractive elements comprise variations in refractive index of the medium.

97. (Canceled) The apparatus of claim 87, wherein the diffractive elements comprise profile variations in the planar boundary of the planar waveguide.

98. (Canceled) The apparatus of claim 87 wherein the diffractive elements comprise thickness variations in a layer of dielectric material overlaying a planar surface of the planar waveguide.

99. (Canceled) The apparatus of claim 87 wherein the planar waveguide comprises a bulk substrate.

100. (Canceled) The apparatus of claim 87, where each of the diffractive elements has a spherical contour and a center of curvature.

101. (Canceled) The apparatus of claim 100, wherein a plurality of the centers of curvature of the diffractive elements are coincident.

102. (Canceled) The apparatus of claim 101, wherein there is one input port and one output port, and where the input port and output port are located at respective conjugate image points of the plurality of the diffractive elements whose centers of curvature are coincident.

103. (Canceled) The apparatus of claim 87 where the transfer function further comprises spectral transformation information.

104. (Canceled) A volume hologram comprising a plurality of diffractive elements operative to accept an input optical signal incident from an input port, the input optical signal having a first spatial wavefront and a first optical spectrum, the volume hologram generating an

output optical signal having a second spatial wavefront and a second optical spectrum, the output signal directed toward an output port, wherein the diffractive elements are configured to map the first spatial wavefront into the second spatial wavefront, and the diffractive elements are configured to map the first optical spectrum into the second optical spectrum.

105. (Canceled) The volume hologram of claim 104 wherein the diffractive elements are distributed in the thickness dimension.

106. (Canceled) The apparatus of claim 12, wherein each portion of the second temporal waveform includes contributions from a plurality of portions of the first spatial wavefront.

107. (Previously Presented) The apparatus of claim 12, wherein each portion of the first spatial wavefront contributes to the second optical signal.

108. (Previously Presented) The apparatus of claim 12, wherein the substrate resides within a planar optical waveguide, the first optical signal interacting with the plurality of diffractive elements while propagating within the planar waveguide, propagation of the first optical signal within the planar waveguide being substantially guided in at least one dimension by the planar waveguide.

109. (Previously Presented) The apparatus of claim 108, further comprising a channel waveguide positioned to introduce the first optical signal into an edge of the planar waveguide through the first port.

110. (Previously Presented) The apparatus of claim 108, further comprising a channel waveguide positioned to receive the second optical signal output from an edge of the planar waveguide through the second port.

111. (Canceled) The apparatus of claim 34, wherein each portion of each of the output temporal waveforms includes contributions from a plurality of portions of the first spatial wavefront.

112. (Canceled) The apparatus of claim 34, wherein each portion of each of the output spatial wavefronts contributes to a plurality of portions of the respective output temporal waveform.

113. (Previously Presented) The apparatus of claim 137, wherein the substrate resides within a planar optical waveguide, the first optical signal interacting with the plurality of diffractive elements while propagating within the planar waveguide, each of the first port, the second port and the third port being positioned at an edge of the planar waveguide, propagation of the first optical signal within the planar waveguide being substantially guided in at least one dimension by the planar waveguide.

114. (Previously Presented) The apparatus of claim 113, further comprising a channel waveguide positioned to introduce the first optical signal into the planar waveguide through the first port.

115. (Previously Presented) The apparatus of claim 113, further comprising a channel waveguide positioned so as to receive the second optical signal output from an edge of the planar waveguide through the second port.

116. (Canceled) The method of claim 45, wherein each portion of the second temporal waveform includes contributions from a plurality of portions of a spatial wavefront of the input optical signal.

117. (Canceled) The method of claim 45, wherein each portion of a spatial wavefront of the diffracted optical signal contributes to a plurality of portions of the second temporal waveform.

118. (Previously Presented) The method of claim 45, the diffractive elements residing within a planar optical waveguide, the first optical signal interacting with the diffractive elements while propagating within the planar waveguide, the first port and the second port being positioned at an edge of the planar waveguide, propagation of the first optical signal within the planar waveguide being substantially guided in at least one dimension by the planar waveguide.

119. (Previously Presented) The method of claim 118, further comprising a channel waveguide positioned to introduce the first optical signal into the planar waveguide through the first port.

120. (Previously Presented) The method of claim 118, the second optical signal being diffracted to a channel waveguide positioned so as to receive the second optical signal from an edge of the planar waveguide through the second port.

121. (Canceled) An optical apparatus, comprising:

a volume hologram including a plurality of diffractive elements exhibiting a positional variation in at least one of amplitude, optical separation, and spatial phase over some portion of the volume of the hologram, the volume hologram residing within a planar optical waveguide, the volume hologram interacting with an input optical signal having a first spatial wavefront and a first temporal waveform to produce an output optical signal having a second spatial wavefront and a second temporal waveform, the input optical signal interacting with the volume hologram

while propagating within the planar waveguide, propagation of the input optical signal within the planar waveguide being substantially guided in at least one dimension by the planar waveguide, the first and second spatial wavefronts differing in at least one of spatial wavefront shape and output direction, the first temporal waveform differing from the second temporal waveform,

wherein each portion of the first spatial wavefront contributes to the output optical signal by scattering from the diffractive elements during propagation through the volume hologram over a distance large enough so that temporal retardation effects within the volume hologram transform the first temporal waveform into the second temporal waveform.

122. (Canceled) The apparatus of claim 121, wherein each portion of the second temporal waveform includes contributions from a plurality of portions of the first spatial wavefront.

123. (Canceled) The apparatus of claim 121, wherein each portion of the second spatial wavefront contributes to a plurality of portions of the second temporal waveform.

124. (Canceled) The apparatus of claim 121 wherein the input optical signal comprises an optical pulse.

125. (Canceled) The apparatus of claim 121, the first spatial wavefront originating from an input optical waveguide, the input optical waveguide being a channel waveguide positioned so as to launch the input optical signal into an edge of the planar waveguide.

126. (Canceled) The apparatus of claim 121, the second spatial wavefront converging to an output optical waveguide, the output optical waveguide being a channel waveguide positioned so as to receive the output optical signal from an edge of the planar waveguide.

127. (Canceled) The apparatus of claim 121, wherein the volume hologram is an optical

waveform cross-correlator.

128. (Canceled) The apparatus of claim 121, where each of the diffractive elements has a substantially circular contour and a center of curvature.

129. (Canceled) The apparatus of claim 128, wherein the centers of curvature of a plurality of the diffractive elements are substantially coincident.

130. (Canceled) The apparatus of claim 129, wherein the input optical signal originates from an input waveguide, and wherein the output optical signal converges to an output waveguide, with the respective input and output waveguides located at respective conjugate image points of the plurality of the diffractive elements whose centers of curvature are substantially coincident.

131. (Canceled) The apparatus of claim 121 wherein the propagation direction of the input optical signal is not collinear to the propagation direction of the output optical signal.

132. (Canceled) The apparatus of claim 121 wherein each of the diffractive elements has an elliptical contour, with each contour having a respective first focus and a respective second focus, and wherein a plurality of the respective first foci substantially coincide, and a plurality of the respective second foci substantially coincide.

133. (Canceled) The apparatus of claim 132, wherein the input optical signal originates from an input waveguide and the output optical signal converges to an output waveguide, and wherein the respective input and output waveguides are located at the respective foci of the diffractive elements whose respective first foci coincide, and whose respective second foci substantially coincide.

134. (Canceled) An optical apparatus, comprising:

at least one of a volume hologram and a feedback structure, including a plurality of diffractive elements exhibiting a positional variation in at least one of amplitude, optical separation, and spatial phase over some portion of the volume of the apparatus, the diffractive elements interacting with an input optical signal having a first spatial wavefront and at least one of a first temporal waveform and a first optical spectrum to produce an output optical signal having a second spatial wavefront and at least one of a second temporal waveform and a second optical spectrum, the first and second spatial wavefronts differing in at least one of spatial wavefront shape and output direction, the first and second optical signals differing in at least one of temporal waveform and optical spectrum

wherein each portion of the first spatial wavefront contributes to the output optical signal by scattering from the diffractive elements during propagation through the apparatus over a distance large enough so that temporal retardation effects within a volume of the apparatus occupied by the diffractive elements transform the input optical signal into the output optical signal.

135. (Canceled) The apparatus of claim 134, wherein each portion at least one of the second temporal waveform and second optical spectrum includes contributions from a plurality of portions of the first spatial wavefront.

136. (Canceled) The apparatus of claim 134, wherein each portion of the second spatial wavefront contributes to a plurality of portions of at least one of the second temporal waveform and the second optical spectrum.

137. (Currently Amended) The optical apparatus recited in claim 12, further comprising:

~~a third port; and~~

a second plurality of diffractive elements within the substrate, the second plurality of diffractive elements being arranged such that

the second plurality of diffractive elements exhibit a positional variation in at least one of amplitude, spatial separation, and spatial phase over some portion of the substrate,

each of the second plurality of diffractive elements provides reciprocal focusing between the first port and ~~the~~ a third port ~~for~~ to the substrate, and

when the first optical signal having the first spatial wavefront and the first temporal waveform is introduced through the first port, the second plurality of diffractive elements

apply a second transfer function to the first optical signal so as to produce a third optical signal having a third spatial wavefront and a third temporal wavefront, wherein the first and third spatial wavefronts differ in at least spatial wavefront shape and the first temporal waveform differs from the third temporal waveform, and

focus the third optical signal to exit the substrate through the third port.

138. (Currently Amended) The optical apparatus recited in claim 12, further comprising:

~~a third port; and~~

a second plurality of diffractive elements within the substrate, the second plurality of diffractive elements being arranged such that

the second plurality of diffractive elements exhibit a positional variation in at least one of amplitude, spatial separation, and spatial phase over some portion of the substrate,

each of the second plurality of diffractive elements provides reciprocal focusing between the second port and ~~the~~ a third port to the substrate, and

when a third optical signal having a third spatial wavefront and a third temporal waveform is introduced through the third port, the second plurality of diffractive elements

apply a second transfer function to the third optical signal so as to produce the second optical signal having the second spatial wavefront and the second temporal wavefront, wherein the second and third spatial wavefronts differ in at least spatial wavefront shape and the second temporal waveform differs from the third temporal waveform, and

focus the second optical signal to exit the substrate through the second port.

139. (Previously Presented) The apparatus of claim 115, further comprising a second channel waveguide positioned so as to receive the third optical signal output from an edge of the planar waveguide through the third port.

140. (New) The apparatus of claim 12, wherein the plurality of diffractive elements are arranged such that, when the transfer function is applied to the first optical signal to produce a second optical signal having a second spatial wavefront and a second temporal waveform, the first temporal waveform differs from the second temporal waveform in duration.

141. (New) The method recited in claim 45, wherein the first temporal waveform differs

from the second temporal waveform in duration.